Assessment and further development of programs for medical therapy using fission neutrons

INTRODUCTION

At FRM II, the MedApp facility delivers a beam of unmoderated fission neutrons for use in medical therapy of tumours. Since high LET radiation (see fig. 1) can deactivate cells rather independently of their phase in the cell cycle, their repair capacities and their oxygenation state, fast neutrons offer advantages especially for the treatment of radioresistant tumours.

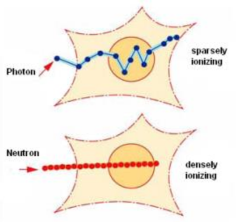

Figure 1: Photon and neutron ionization tracks in cell

OBJECTIVE

This work is focussed on the adaptation of an existing treatment planning program to the MedApp beam. A personalised calculation of the dose distribution taking into account patient morphology, tissue composition and densities will improve the accuracy of the predictions of the dose absorbed by different tissues and helps to assess possible side effects.

Simulation Environment for Radiationtherapy Applications

From several simulation tools, SERA was chosen because of the well developed graphical possibilities. The system, created by INEEL/Montana State University group uses a tailored Monte Carlo code called seraMC based on multigroup photon and neutron cross sections libraries with 94 neutron energy groups. SERA produces a patient model using the pixel by pixel uniform volume element (univel) reconstruction method.

The resulting dose contours are displayed in the original image planes (see fig.2). This representation allows determining the beam position and the irradiation time in due consideration of the given healthy tissue limits.

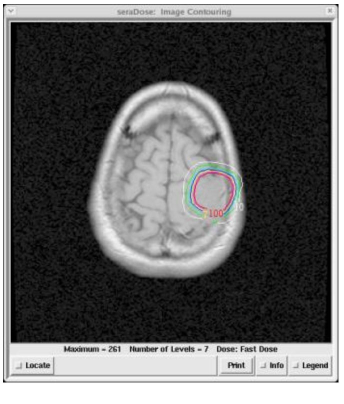

Figure 2: Isodose curves representation by SeraDose Module

VALIDATION OF THE DOSIMETRIC TOOL

Calculations of the dose distribution in a water phantom were compared to measurements (see Fig. 3). Moreover, calculations with human voxelised phantoms were carried out in order to test the suitability of the program for human dosimetry.

Figure 4 shows good agreement of phantom measurements and the depth dose rates calculated with SERA. The depth dose curves obtained by use of the general simulation program MCNPX gives further evidence.

Figure 3: Water phantom in the MedApp irradiation room

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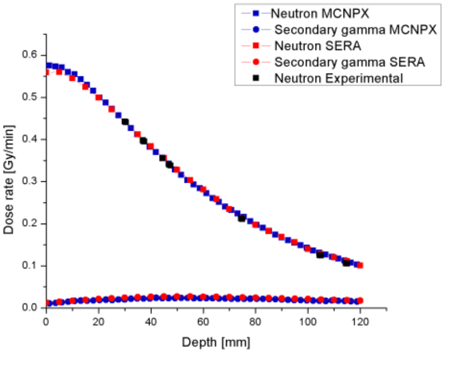

Figure 4: Neutron and secondary gamma depth dose rate in a water phantom

CONCLUSION

The verifications demonstrated that SERA has enough performance for the retrospective dose planning of neutron medical therapy with fission neutrons..

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